running a chronic course or causing permanent joint damage, the causative micro-organisms of which are not positively known. These must, therefore, for the present be called infectious polyarthrites. There is one form, first described by Schueller (arthritis villosa), which, because of the enormous proliferation of the synovial fringes, might be called infectious villous arthritis. Whether the bacteria described by Schueller as the cause are the only ones which produce this condition is as yet not definitely settled.

Toxæmic arthritis corresponds to the so-called pseudorheumatism of pulmonary tuberculosis and allied conditions. It is a purely synovial form of joint disease and in this differs radically from toxæmic osteoarthritis. The latter corresponds to Pierre Marie's osteoarthropathic hypertrophiante pneumique. In the cardiac cases, with the exception of the disability caused by the enlargement of the articular ends of the bone, there is rarely any true joint involvement.

In the present state of our knowledge it is quite unnecessary to offer an apology for suggesting a new classification of the joint diseases. The scheme here proposed I have found most satisfactory in my own work, and this led me to believe it might prove useful to others.

It would have made the paper too complicated had I included the details of my work on the pathology, and for this reason I left this part of the subject for a future, purely technical paper. However, those with specimens of joints, including the bones, can readily verify what I have said here. The *x*-rays are by Dr. L. G. Cole.

LUMBAR PUNCTURE.

A GENERAL REVIEW OF ITS VALUE AND APPLICABILITY.

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Lumbar puncture, to which the medical world was introduced by Quincke, has from the time of its birth commanded so wide a divergence of opinion, both in the field of therapy and as an aid to the art of diagnosis, that it has become a veritable bone of contention, not only to the otologist, but also to those whose fields of labor are in other branches of medical science.

At first a therapeutic measure, the procedure was early recognized as affording a source from which to draw inferences to aid in clearing up doubtful diagnoses. Incidentally it pointed a way to secure anæsthesia in certain limited major operative work, and recently it has again been brought to the attention of the medical profession as a therapeutic measure in the treatment of ear affections.

It was the author's intention to classify and study the various opinions extant, to sum up and epitomize these opinions so as to place, if that were possible, the indications and value of lumbar puncture from the otological standpoint, but the subject broadened itself. No better illustration could be afforded of the inter-relations existing between the various branches of medicine than the applicability of this procedure in surgery, neurology, pathology, otology, and general medicine. In order therefore to arrive at a clearer and truer understanding of the question, the whole subject was gone over.

While not claiming to have noted each and every article in literature bearing upon the question, still the most important ones have been carefully studied. The results arrived at are hereby published in order to give a general *résumé* of a subject which, when properly placed and intelligently employed, cannot but be of great importance to all medicine.

The subject resolves itself into the consideration of lumbar puncture from three distinct view points:

I. As an aid to diagnosis.
II. As a therapeutic measure.
III. As a procedure to produce anæsthesia.

I. AS AN AID TO DIAGNOSIS. From an originally empirical procedure, lumbar puncture has developed into a highly scientific exploratory method. The chemical and bacteriological character of the spinal fluid has been studied with great care in Germany. The practical value of this diagnostic measure was nehanced in France by applying to the fluid the method known as cytodiagnosis of Widal, Ravaud, and Sicard with its greater precision and more definite formulæ.

In contradistinction to the bacteriological examination of the cerebrospinal fluid with its direct demonstration, cultures, and animal inoculation, the cytodiagnostic or histological method consists in the microscopic determination, in the obtained fluid as withdrawn, or after centrifugation, of the several varieties of leukocytes which are differentiated in accordance with their morphology and their staining affinities. The cytological formulæ established by Sicard, Widal, and Ravaud express the practical application of the histological method.

The bacteriological and the cytological examination were soon extended by cryoscopy (Widal, Sicard, and Ravaud), chromodiagnosis (Sicard), chemical analysis applied to certain forms of meningitis (Sobrazes, Deniges, and Wulf), and finally the study of meningeal permeability, etc.

Essential points in the technique of the examination of cerebrospinal fluid are:

1. The pressure under which it is obtained.
2. Its coloration (chromodiagnosis).
3. The bacteriological findings.
4. Cytodiagnosis.
5. The chemical examination.
6. Cryoscopy of the fluid.

Normal cerebrospinal fluid is a clear transparent liquid, with a specific gravity of 1003 to 1004 (Archard and Laubry[79]), and usually of a quantity varying from 60 to 100 grams, which is sometimes increased to 300 and even 400 grams in the aged. Under abnormal conditions the color is often altered, and the specific gravity varies from 1002 to 1009 (Archard, Laubry).

1. *Pressure.* The degree of pressure under which the cerebrospinal fluid is obtained is easily recognized without instruments by the strength of the spurt and the height of its curve during withdrawal. Slow evacuation, drop by drop, indicates hypotonia, while a fountain spurt, the patient in a recumbent position, gives evidence of a rise of pressure. Pressure is subject to considerable vacillation in the same patient, and during the same posture, depending upon the position of the head, cardiac pulsation, and respiratory activity (Reiken[56]).

According to Quincke, pressure rises in grave inflammatory conditions, in tuberculous meningitis, and in brain tumor; the highest observations recorded are those in tuberculous meningitis and acute hydrocephalus.

Lermoyez[57] noted a behavior of the puncture liquid, simulating a urinary stream issuing under strong pressure, in a case of brain abscess of otitic origin.

The diagnostic importance of pressure is on the whole a limited and secondary one, Quincke himself admitting that the height of the pressure curve does not indicate the nature of the disease.

2. *Coloration.* For the summary of characteristics obtained from the coloration of the cerebrospinal fluid, Sicard proposes the name "chromodiagnosis." He considers this part of the examination as very reliable and instructive. Unfortunately the cases with distinct modification of color are usually the least obscure clinically.

Wentworth[58] suggests careful comparison of the fluid received from spinal puncture into a test tube with distilled water contained in a similar tube. The normal appearance may be altered by accidental or pathological admixture with blood or micro-organisms. Blood is easily recognized. Leukocytes contained in the fluid cause a characteristic turbid appearance, although there is a record of an observation by Braunstein in which the fluid was cloudy without hyperleukocytosis or other formed constituents (probably as a result of unrecognized chemical changes).

In a general way coloration is affected in acute meningeal inflammations, exceptionally in these conditions the fluid may remain clear.

The discoloration varies from almost clear to a general yellow, and from the slightest trace of cloudiness to a well-defined purulent turbidity in cases of acute bacterial meningitis. In chronic meningitis the fluid will generally be found clear, but occasionally it presents a greenish-yellow color (Raymond, Widal). In tuberculous meningitis Widal found it usually clear, sometimes opalescent; on the other hand, Wentworth always found it more or less cloudy. It was clear in only 5 per cent. of the cases of Bernheim and Moser.[60] From admixture with pigment derived from bile or from blood serum it may present a yellowish or greenish-yellow color in cases of icterus (Widal, Sicard, and Ravaud[61]).

So much variability in the coloration of the fluid has been observed by Foster[59] that he places no faith in the data obtained from the color examination.

3. *Bacteriological Findings.* The bacteriopathology of puncture fluid has been extensively studied since the introduction of the method. Nearly all forms of micro-organisms have been found in it, foı there may be a mixed infection, with other bacteria than those pathognomonic of the disease in any given condition. Diplococci are especially common in affections of the spinal meninges, but true gonococci are rarely found. Weichselbaum's diplococcus intracellularis, the accepted cause of cerebrospinal meningitis, if found settles the diagnosis in this disease. This is generally demonstrated without difficulty, and may be distinguished by culture methods from the micrococcus catarrhalis, which is much more easily grown in lower temperatures and on all kinds of culture media. In otogenic infections arising from a pathological process in the region of the ear there may be no micro-organisms at all in the cerebrospinal fluid (Hastings[80]).

Kroenig[81] demonstrated granular detritus nerve fibres containing myeline, free myeline, and blood crystals in the bacteriological findings of the spinal fluid.

He examined the fluid from four cases during life which later came to autopsy, and his diagnosis previously made by puncture of cerebral foci of softening with rupture into the subarachnoidal space was borne out by the postmortem findings.

In the fluid withdrawn from hemiplegics the signs of older hemorrhages into the brain substance or the meninges were demonstrated in the form of hæmatoidin and hæmosiderin. The finding of these latter in the fluid might be of eventual value in the differential diagnosis between embolism and hemorrhages. He was never able to demonstrate tumor elements, although he once was able to diagnose a rupture of a brain tumor, which was confirmed at autopsy, from the detritus found in the puncture fluid.

Bacteriological examination includes direct investigation, cultures, and inoculation. Cytological diagnosis does not exclude bacteriological examination. The bacteriological test made directly and by culture may be performed at the bedside (Sicard[62]).

The direct examination is made according to laboratory methods in common use for research work of this kind. Stadelman has shown that bacteriological findings, notably of the tubercle bacillus, depends largely upon the worker's skill, consequently he considers only positive findings of diagnostic value.

In acute cases where the medical or therapeutic interference must be prompt on account of imminent danger to life the direct examination is the only method of practical use. Cultures and animal inoculations presuppose so much time that these procedures are adaptable only to chronic cases and to the tuberculous form of meningitis.

One seeks bacilli on the fibrinous threads which form in the tube after standing or after centrifugation of the fluid.

In the so-called microbial forms of meningitis many kinds of bacteria have been found, the staphylococcus (Josias, Netter, Stadelman, etc.), the streptococcus, Fraenkel's and Weichselbaum's pneumococcus, the Ebert bacillus (demonstrated by Wentworth and Lenhartz), the colon bacillus, the tubercle bacillus, and many others.

The tubercle bacillus, especially, has caused great trouble and raised much discussion. It is not found in all cases, and the variable results are explained by the different methods employed by the respective workers. Kroenig[64] attributes failure to an imperfect centrifugation, or to a poor stain; he states his belief as to the possibility of demonstrating tubercle bacilli in each and every case of tuberculous meningitis.[65]

Schwartz[66] endorses Furbringer's method of spontaneous clot production after permitting the fluid to stand twenty-four hours as preferable to centrifugation of the fluid; he divided the fluid into two parts, one of which was subjected to centrifugation and demonstrated the bacilli only in the untreated portion.

The absence of tubercle bacilli may be due to the fact that the meningeal tubercles have not broken down, or that they are limited to the cranial meninges and the communication between the two cavities is clogged or obliterated, or that the puncture has penetrated into the subdural space (Stadelman[67]). This opinion is plausible for certain cases, but less satisfactory than the explanation of negative findings by reason of faulty technique.

When found the tubercle bacilli are always present in small numbers, a warning that not every rod retaining the stain after the Ziehl solution and sulphuric acid discoloration should be considered as Koch's tubercle bacilli is sounded by Griffon and Philibert.

As to the culture methods, the advantages of conclusive results are offset by the delay in the appearance of the culture growths, usually two or three weeks. This prevents the practical application of culture methods for diagnostic purposes in the majority of the intracranial complications of middle ear disease.

Negative results do not by any means demonstrate the absence of micro-organisms in the cerebrospinal fluid. The cultures may prove failures because the medullary canal did not share in the inflammatory process, or because the fluid itself had bactericidal properties preventing the preservation of bacterial vitality or virulence, or because these bacteria have become independently attenuated (Leutert). The pneumococcus and the meningococcus are feebly virulent in the purulent exudate of meningeal inflammation, and they yield no culture for from eight to ten days after the onset of the disease (Concetti[24]).

Besancon and Griffon obtained a positive result in regard to the tubercle bacillus by adding a few drops of the fluid to gelatinized blood. Twelve to fifteen days later the colonies were visible to the naked eye.

Animal inoculation is of especial value for the demonstration of tubercle bacilli, but the method demands at least three weeks' time. The fluid is introduced into the peritoneum of guinea-pigs; the results may be negative for similar reasons as in the case of the cultures, generally on account of the diminished virulence or the small numbers contained in the inoculated fluid.

Inoculation was successful in 27 per cent. of the cases of tuberculous meningitis of Bernheim and Mosser, and in 30 per cent. of those of Netter. The scientific accuracy of these examinations is incontestable according to Variot.[68] Their value is, however, only relative for the clinician who requires prompt information. The answer from the laboratory comes of necessity so late that in the case of tuberculous meningitis the paralytic phenomena of the final stage will precede and confirm them (Chavasse and Mahu).

4. *Cytodiagnosis.* This method of examination, recently introduced by Sicard, Widal, and Ravaud (1900), consists, as already indicated, in the histological study of the cellular elements contained in the spinal fluid, this study being based on the determination of the number and nature of its formed elements. Remarkable practical results have been obtained by this method, which Wentworth[84] had suggested in 1896 and Bernheim and Mosser[85] in 1897, for the study of meningeal affections.

By means of cytodiagnosis as a routine measure certain cytological formulæ have become established in connection with various cerebral or cerebrospinal affections.

Normal cerebrospinal fluid or fluid unaltered by general or nervous diseases contains only a few leukocytes, not more than one or two in the microscopic field. When, on the other hand, the meninges are the seat of irritation or inflammation, formed elements appear in the fluid whose number and character vary with the intensity and nature of the inflammatory process, representing at once a qualitative and quantitative reaction.

The technique of the method is described in detail in the works of Widal, Sicard, and Ravaud, and is of easy and practical applicability. The succeeding microscopic examination must be made with the greatest care and thoroughness, since the leukocytes may be unevenly distributed—being occasionally much more numerous on some slides than on others. The observer must be able to recognize, differentiate, and count the different elements (Sicard[86]).

The lymphocytosis of the cerebrospinal fluid indicates only the presence of meningeal irritation, and therefore does not in itself furnish information as to the nature of the irritating process. Being simply a sign of meningeal irritation, it does not invariably indicate meningitis. Dana[151] found increased lymphocytosis present in two cases of paresis, while in two other cases the fluid was clear.

Lymphocytosis of the spinal fluid is especially observed in chronic meningeal affections, as for instance in tabes,[91] multiple sclerosis, syphilis, and tuberculous meningitis.

Polynucleosis is the sign of an acute and violent irritation. It is usually found in acute non-tuberculous meningitis from various causes (pneumococcus, staphylococcus, meningococcus). At this stage the fluid contains almost solely polynuclear leukocytes, generally in sufficient numbers to give the fluid a cloudy aspect. Sometimes the fluid appears normal and the polynuclear leukocytes are only discoverable after centrifugation. It has been noted of the fluid, especially in cerebrospinal meningitis, that the polynuclear leukocytes decrease as recovery progresses, then they are replaced by lymphocytes, which in their turn gradually disappear when recovery is complete (Labbi and Castaignes, Sicard and Bricy).

Polynucleosis has been occasionally observed in tuberculous meningitis. According to Braunstein it is often found in suppurative meningitis complicating middle-ear disease. Leutert states as a result of his work on the complications of middle-ear disease that a marked general leukocytosis usually strongly suggests meningitis, an opinion shared to some extent by Lenhartz. Polynuclear leukocytosis, as always suggestive of meningeal inflammation, had previously been commented on by Stadelman, Bernheim, Mosser, Lichtheim, and Wentworth.

5. *Chemical Examination.* For purposes of diagnosis the chemical character of the cerebrospinal fluid is indifferent and devoid of practical value in ordinary cases. The normal reaction is alkaline, presenting a considerable proportion of sodium chloride, and containing neither fibrinogen nor fibrin ferment. In meningeal inflammations the albumin increases, especially in the suppurative forms where it may reach 7 or even 9 per cent. In such cases, however,

the diagnosis can be made by the gross aspect of the fluid. Daskiewitz-Korybut believes that a percentage of more than 1 per cent. in the albumin points to inflammatory processes and should be taken as a contraindication of tumor.

Reiken[83] holds that in tuberculous meningitis the average of albumin is about 2 per cent.

Fuchs[152] believes that there is still much room for improvement in the technique of the physical and chemical methods of examining the spinal fluid. He attaches great importance to the determination of the freezing point and to the electrical conductivity of the fluid.

The constant raising of the freezing point in all forms of meningitis, and the disturbances in the relative values of the electrical conductivity and the freezing point he interprets as an alteration in the relative proportions of organic and inorganic constituents, which he believes occurs in meningitis exclusively.

6. *Cryoscopy.* The determination by cryoscopy of the osmotic tension of the cerebrospinal fluid means the establishment of its coagulation point as compared to that of blood serum, and has been employed by Sicard, Widal, and Ravaud.[87] This procedure necessitates special instruments, and Bard prefers hæmatolysis according to the Hamburger method of determination of the isotonicity of saline solutions. This procedure consists in trying if the cerebrospinal fluid is stained by the influence of a few drops of blood added to the puncture fluid, which is then subjected to centrifugation. In the normal state the cerebrospinal fluid does not "leak," but "leakage" occurs when it is in a state of hypotonia. Bard,[88] however, admits the inferior value of hæmatolysis as compared to cytology in the diagnosis of acute forms of meningitis, since it does not assist materially in the differential diagnosis, presenting "leakage" in tuberculous meningitis, and even in slight inflammatory conditions and meningeal implications due to profound intoxication.

Interesting as they are from the scientific view exclusively, the results of cryoscopy and hæmatolysis up to the present writing are possessed of almost no practical value.

Summing up these various methods of examination of the spinal fluid, it should be borne in mind that it is not so much a given characteristic of the cerebrospinal fluid, but the totality of its examination which should furnish diagnostic indications, and the results of this examination should always be considered in connection with the clinical development of the case. Erroneous conclusions are only too easily arrived at in the difficult cases where lumbar puncture is undertaken in order to assist an uncertain or a doubtful diagnosis.

Significance of Pathological Findings. During the first period of intercranial complications of middle-ear disease, at a time when judicious interference may serve to rescue the patient's life, diagnosis frequently presents enormous and even insurmountable difficulties. The importance of the specialist's decision in these serious cases is such that he is called upon to resort to all the exploratory methods furnished him by general medicine for the solution of his complicated problem.

The presence of otitis media does not by any means exclude the possibility of a cerebrospinal meningitis or a tuberculous meningitis, both entirely independent of the ear disease proper. The existence of a chronic tuberculous otorrhœa creates an equal predisposition for the development of a tuberculous meningitis, as it does for that of a simple purulent meningitis from infection by contiguity.

The choice between the two may occasionally prove most embarrassing (Luc[70]).

Stadelman[71] stated ten years ago that the differential schedule to distinguish purulent meningitis, tuberculous meningitis, and brain abscess was as follows: A clear fluid with tubercle bacilli indicates tuberculous meningitis. A turbid liquid, clouded up to purulency with various forms of micro-organisms, means suppurative meningitis, and a clear liquid without micro-organisms points to brain abscess.

This summary, although not infallible, represents considerable progress in the diagnosis of intracranial complications of ear disease. But the advance that has since that time been made in the methods of examination of the cerebrospinal fluid, coupled with a wider knowledge of ear complications, permits of a new and generally applicable—although not yet perfect—schedule fitting the majority of cases. According to Chavasse and Mahu[72] a clear normal non-coagulable fluid indicates sinus thrombosis, brain abscess (epi- or subdural), simple serous meningitis, meningismus, hysteria, and occasionally a circumscribed meningitis. If the fluid comes away in spurts under pressure the probability of serous meningitis, sinus thrombosis, or more rarely brain abscess, is increased. A clear fluid without bacteria or coagulating elements makes for a probable diagnosis of meningitis, toxic (?) or tuberculous. A clear or yellow or slightly turbid fluid with predominating lymphocytosis, or the tubercle bacilli, indicates tuberculous meningitis after clinical elimination of other causes of lymphocytosis, if there are no tubercle bacilli present. An opalescent or purulent fluid, forming a coagulum, with predominating polynucleosis, and eventual presence of various micro-organisms, means acute diffuse meningitis, purulent or non-purulent, cerebrospinal meningitis (provided Weichselbaum's meningococcus is present), and if the puncture is hurried—*i. e.*, the fluid aspirated—sometimes it indicates a circumscribed meningitis.

Apart from the clinical symptoms, lumbar puncture does not give the mathematical certainty of establishing the differential diagnosis between brain abscess, serous meningitis, meningismus, or sinus thrombosis. It is thus shown that lumbar puncture fails precisely for the differential diagnoses of greatest importance to the otologists, leaving doubt also as to the existence of a circumscribed meningitis.

The opinions of observers who have made a special study of lumbar puncture vary widely as to the practical value of *positive* results of the examination of the spinal fluid—meaning a change in the constituency of the fluid—and of *negative* findings—meaning a normally constituted fluid.

Stadelman in 1895 considered negative results as devoid of value, especially for differential diagnosis between brain abscess and purulent meningitis. Since that time he has modified his opinion. Braun[73] admits only positive findings for the diagnostication of meningitis, and Lichtheim[74] reports a case diagnosed as diffuse meningitis because the fluid was cloudy from the presence of leukocytes, but which turned out to be a circumscribed meningitis.

Leutert[75] and also Cheney[82] attach importance to a negative finding, the object of the former being especially to exclude meningitis. He takes a quantity sufficient in amount (12 to 15 cm.) to ascertain the withdrawal of the fluid from the cranial cavity.

Chavasse and Mahu consider this last condition as superfluous, as demonstrated by recent application of the cytodiagnostic method the cerebrospinal fluid is not a stagnating, stationary liquid, there being a constant interchange between the cranial and the spinal cavities.

According to Leutert, an objection to placing too much value on negative findings is the possibility of an existing obstruction of the communication between these two cavities. This obstruction is demonstrated when it is possible to withdraw only a very small quantity of the fluid.

Grunert[76] agrees with Leutert in trying to exclude diffuse purulent meningitis by lumbar puncture. He lays great stress on the data derived from the clinical picture.

Braunstein summarizes the conclusions of Leutert and Schwartz laid down at the "Versammelung Deutsche Naturfoerscher und Aerzte zu Hamberg, 1901," as follows: A negative result, fluid clear and normal, definitely excludes the existence of diffuse purulent meningitis. A positive result, fluid turbid from increase of leukocytes, with presence or absence of micro-organisms, demonstrates the existence of diffuse purulent meningitis, or of cerebrospinal meningitis (if the meningococcus intracellularis is present). Braunstein does not consider it essential that the leukocytes present must be polynuclear, but he admits that the fluid may show turbidity in cases of brain abscess.

At a time when the cytodiagnostic method was not yet in use Luc wrote that in a doubtful diagnosis between encephalic abscess and meningitis the absence of microbes in the fluid withdrawn by puncture and the inocuity of the fluid when inoculated into laboratory animals presented strong presumptive evidence in favor of brain abscess.

Koerner[77] considers lumbar puncture as a frequent but not invariable positive diagnostic measure in otitic leptomeningitis. He makes the reservation that a fluid slightly cloudy with bacteria may be found in diffuse as well as in circumscribed meningitis, and that there may be circumscribed meningitis with a clear fluid.

Schultz[78] declares that neither the macroscopic aspect of the trouble nor the microscopic evidence of increase of leukocytes are in all cases sufficient for the establishment of the diagnosis of diffuse purulent meningitis; he, however, attributes great importance to the bacteriological examination which, as we have already seen, unfortunately are often a failure, as are also the attempts at making cultures.

Cytology as applied to general medicine furnishes some points of interest for the study of the otitic forms of meningitis. Netter[92] does not consider a clear fluid a conclusive proof of the absence of meningitis; moreover, the aspect of the fluid may vary with the time of the puncture. Archard and Laubry[79] believe that if positive results of lumbar puncture are taken to indicate the presence of meningitis, a negative result should not be held as irrefutable proof that no meningitis is present. For Sicard, the withdrawal of a clear fluid without leukocytes suffices, given the presence of doubtful meningeal symptoms to determine the absence of a meningeal inflammation.

Differential Diagnosis. In children especially tuberculous meningitis and cerebral tubercles are often observed, either as a complication of tuberculous otitis or as an accompanying result of non-tuberculous ear disease; moreover, tuberculous meningitis is often incorrectly diagnosed as ordinary meningitis or even as brain abscess. In order to prevent an eventual useless operation the examination of the cerebrospinal fluid is resorted to as a diagnostic aid.

The fluid obtained in these cases is generally clear and transarent, sometimes greenish yellow or tinged with blood.

Wentworth claims that, when compared to distilled water, the fluid is almost invariably cloudy. It flows out under pressure, and the coagulum which forms in it is muddy, white, or gray, quite hard, and not easily smeared on slides (Netter). The tubercle bacillus is demonstrable microscopically in about an average of 50 per cent. of all cases, always in small numbers. Not so long ago the demonstration of the tubercle bacillus meant the crucial test for the presence of tuberculous meningitis, and as this examination was frequently negative, Monti[100] held that lumbar puncture was devoid of value as an aid to diagnosis. Friedjung[101] held similar opinions. But the significance of the examination has been materially changed by the work of Widal, Sicard, and Ravaud, as already described. Cytodiagnosis invariably shows an excess of lymphocytes, sometimes mixed with polynuclear leukocytes and endothelial cells.

In some cases this lymphocytosis seems to have led to a diagnosis of tuberculous meningitis when there was present only a simple meningitis, as demonstrated at autopsy.

Diffuse purulent meningitis due to various microbes is the most commonly observed form of this disorder as a complication of suppurative middle-ear disease. In diffuse suppurative leptomeningitis arising as a complication of ear trouble, or accompanying sinus thrombosis or brain abscess, the fluid withdrawn by puncture is changed both macroscopically and microscopically. The seat of the suppurative process is commonly the subarachnoidal (exceptionally the subdural) space. The fluid is accordingly seen to be cloudy, greenish yellow, sometimes typically purulent, very frequently containing various forms of microbes, such as the staphylococcus, the streptococcus, the pneumococcus, etc., and considerable quantities of leukocytes. The pressure varies from high (Stadelman) to low (Chavasse and Mahu). Cytodiagnosis confirms the typical increase of polynuclear leukocytes in suppurative meningitis, especially of the otitic form (Leutert[102]). Braunstein believes that the presence of bacteria is not essential for the diagnosis of meningitis, but that a hyperleukocytosis with a turbid fluid points directly to the existence of a purulent meningeal inflammation. In a case of suppurative meningitis observed by Chavasse and Mahu the puncture fluid contained many polynuclear leukocytes and some pneumococci. In another case, one of multiple brain abscess, the fluid was slightly opalescent and cytodiagnosis demonstrated the presence of many polynuclear leukocytes. In a case of suppurative cerebrospinal meningitis following posterosuperior mastoid cellulitis, the fluid obtained by puncture was found to be cloudy and to contain pneumococci.[103]

Lumbar puncture performed on a patient suffering from meningitis developing a month after mastoid abscess, yielded 4 to 5 c.c. of fluid in which cytodiagnosis demonstrated the presence of formed elements, while bacterial cultures proved negative. In the majority of cases of purulent meningitis of otitic origin Chavasse and Mahu claim that the diagnosis is facilitated by the determination, first, of a cloudy fluid, and second, a cloudy fluid with predominant polynuclear leukocytes. In one of the cases observed by Lichtheim the fluid was not cloudy, notwithstanding an extensive basal meningitis; in another the fluid was cloudy, but did not contain any polynuclear leukocytes.

Turbid fluid without bacteria or hyperleukocytosis is mentioned by Heinike[104] as occurring in one of his cases.

Lumbar puncture practised on a child with chronic mastoiditis, complicated with a disease whose clinical picture was that of leptomeningitis, yielded a clear fluid under moderate pressure in which the microscopic examination after centrifugation showed neither corpuscles nor micro-organisms. Agar cultures remained sterile. Autopsy, however, demonstrated suppurative leptomeningitis with a turbid fluid in the ventricles (Witte and Sturm).[105]

Grossmann[106] had results from puncture in one case which would have led him to the diagnosis of diffuse meningitis, but notwithstanding his findings, he operated upon the case and the symptom-complex cleared up entirely; in another, a case of general otitic sepsis, the fluid was cloudy and contained pus elements, but upon autopsy no meningitis was demonstrable. This last case is hardly one from which to draw inferences as to the diagnostic value of the puncture method, as I believe that when a general sepsis supervenes, whether it comes as a complication of middle-ear disease or after surgical measures, if advanced to any extent, all the fluids of the body will give evidence of pus elements.

Cohen[107] insists that the fluid is almost always abnormal in suppurative meningitis provided the puncture is not undertaken too early in the course of the disease.

Obliteration of the connecting passage between the spinal and the cranial cavities is assumed as an explanation of the normal fluid withdrawn by puncture in a case of meningitis, which diagnosis was confirmed by autopsy by Archard and Laubry.[108]

Strauss[109] also accounts for these peculiar observations by the occlusion of the foramen of Magendie by the inflammatory exudate.

In cerebral or cerebellar abscess uncomplicated by other affections, intercranial in their nature, or by sinus thrombosis, diffuse or circumscribed meningitis, the fluid is, as a rule, normally clear, without organisms, and yielding no coagulum. After centrifugation Lermoyez [110] found the clear fluid to be normal. The quantity of the fluid may be altered by the existence of sinus thrombosis, but it generally remains clear (Laurens).[111]

Constade[112] noticed a dripping evacuation, drop by drop, of a clear fluid from a child eleven years of age who died of lateral sinus thrombosis confirmed by autopsy.

A circumscribed suppurative meningitis may present the same symptoms as the diffuse form of the disease, and here lumbar puncture is quite apt to yield a normal negative fluid. Where there are symptoms of circumscribed otitic meningitis Grunert[113] points out the eventual existence of a circumscribed meningitis proper. According to Hinsberg[114] a clear and sterile fluid does not absolutely contraindicate a circumscribed inflammatory focus. Koerner[115] believes that a slightly turbid fluid with bacteria may be found as *well in diffuse as in circumscribed meningitis, and that there may* be circumscribed meningitis with a clear fluid without pus elements or micro-organisms.

Lannois and Armand[116] report a case of cerebellar abscess by extension from a suppurating labyrinth, complicated by a localized meningitis, in which they withdrew by puncture 30 to 40 grams of slightly turbid fluid which after centrifugation showed many polynuclear leukocytes with indistinct and faintly stained nuclei, and a few mononuclear leukocytes but no lymphocytes.

In pachymeningitis, intradural abscess, and extradural suppurations the fluid may retain its normal composition; thus, Braunstein made several observations concerning extradural lesions, even when complicated with cellebellar abscess, in which the puncture yielded a clear and normal fluid, and Laurens[117] withdrew transparent fluid from a case of extradural abscess with pachymeningitis of otitic origin. On the other hand, Berstelmann[118] obtained cloudy fluid with deposits of many leukocytes and a few fine specimens of the diplococcus intracellularis from a case of extradural abscess which *terminated in recovery after surgical* interference. The composition of the fluid may eventually be accounted for by the existence of a slight cerebrospinal meningitis.

In cases of intradural abscess lumbar puncture may yield a clear fluid without leukocytes or micro-organisms or formed elements, as shown by cytodiagnosis (Leutert).

Bacteriological and cytological examinations have not given much information on the subject of the various forms of serous meningitis, as observed with special frequency in infancy and childhood and so frequently confounded with cerebral abscess (Broca and Laurens,[119] Leyden,[120] Hegener,[121] and Boenninghaus).[122]

Of the various forms of ear disease the simple mastoid affections are the only ones which do not cause a modification of the cerebrospinal fluid. This should be kept in mind because of the existence of certain morbid conditions simulating or complicating this ear disease.

I cannot complete the study of the diagnostic possibilities of lumbar puncture without touching upon a series of symptoms to which the name "meningismus" has been applied.

There are a series of symptoms occasionally observed in the course of suppurative middle-ear disease, especially in children, but occasionally in adults, which simulate either simple or tuberculous meningitis and brain abscess. In these cases no inflammatory lesion is supposed to exist, and to this symptom-complex the term "meningismus" is restricted. It does not include the serous forms of meningitis (Dupre,[123] Gelle, Massin, Chavasse[124]).

For the development of meningismus, hysteria and neurasthenia have been held accountable, and Lermoyez has attributed it to reflex symptoms from a suppurative inflammation of the labyrinth. Dopter[125] has observed meningismus in cases of typhoid fever.

In true meningismus, which is simply the manifestation of functional trouble without implication of the serous membranes, the cerebrospinal fluid is normal, according to Widal and Lamouroux.[126]

In two cases of labyrinthine disease, both females, in whom no hysterical elements were demonstrable, the fluid withdrawn by puncture flowed without heightened tension, was clear, and contained no formed elements (Chavasse and Mahu).

In ear disease, acute non-tuberculous meningeal inflammations are of frequent occurrence, and according to Netter[127] the milder and non-purulent forms may retrocede rapidly without leaving traces behind them. In these cases lumbar puncture will yield a clear and apparently normal fluid, which after standing some hours presents scanty flakes of fibrin and may contain albumin and some pneumococci.

Merkens, Brieger, and Koerner admit the possible occurrence of a serous meningitis due to a penetration of toxins from a suppurative otitic focus to the meninges. The toxin of the pneumococcus circulating in the blood has been held responsible for the development of the condition by Belfanti and Hutinal.[128]

Cerebrospinal fluid then is seen to be normal in composition in labyrinthine disease and in meningismus, while in brain abscess, lateral sinus thrombosis, and non-bacterial serous meningitis it may be clear and normal, but it is often increased in amount and generally flows under heightened pressure.

The conflicting observations obtained from diffuse meningitis may in a measure be accounted for by the fact that in certain of their cases the differential diagnosis between diffuse, simple, tuberculous, and non-tuberculous meningitis and miningismus had not been made, especially the differential diagnosis between diffuse meningitis and the condition known as meningismus. Reading certain results obtained by puncture one is inclined to believe that the observer was dealing with meningismus rather than with a meningitis proper. Taking those cases where there was present a clear and normal fluid, and in which the diagnosis was not confirmed by autopsy, and classifying them under the heading "meningismus," the diagnostic data reads clear and distinct.

In summing up the diagnostic possibilities of lumbar puncture we are inclined to believe it a measure of great value, especially when undertaken rather to clear up doubtful diagnoses than to substantiate probable ones. The data obtained should invariably be considered with the clinical evidence of the disease, and where the question involved is one as to whether or not surgical interference should be undertaken, it is well to give the patient the benefit of the doubt.

II. As a Therapeutic Measure. In 1891 Quincke,[1] after extensive experimentation on dogs and rabbits, performed the first original operation of lumbar puncture on a patient—a child two years old—for the purpose of relieving a fresh hydrocephalic effusion, with pressure symptoms, by means of withdrawing cerebrospinal fluid. The puncture was repeated three times at intervals of several days, resulting in an almost complete recovery of the patient.

The lucky outcome of his brilliant venture encouraged the surgeon to further experimentation, and he published his results in an article on the physiological and pathological conditions of pressure on the cerebrospinal space, as well as the physical and chemical constitution of the fluid withdrawn by puncture, in various conditions of the disease.[2] It was not long before Quincke had performed the operation twenty-two times on ten individuals.[3]

While Quincke had had a fair proportion of therapeutic success, Lichtheim,[4] working at Koenigsberg, reported on a series of spinal punctures performed by him without relief to the patients. Even very pronounced symptoms, in cases of brain tumor, were not even transitionally relieved by the withdrawal of very large amounts of cerebrospinal fluid (80 cm.). Notwithstanding these negative results Lichtheim believed that lumbar puncture possessed diagnostic value.

The experience of Ziemssen[5] with Quincke's puncture was favorable in so far as he observed improvement of pressure symptoms after the operation, especially finding relief from oppressive headaches. He pointed out the advantage of utilizing the cerebrospinal fluid thus obtained for admixture with medical agents.

Wyss[6] reported a case of hydrocephalus in a child eight months old improved by six ventricular and one lumbar puncture, and Dennig[7] obtained postmortem a large quantity of tubercle bacilli by means of spinal puncture from a case of tuberculous meningitis.

The finding of tubercle bacilli has frequently been duplicated, notably in the remarkable case of tuberculous meningitis ending in recovery reported by Freyhan.[8]

After 1895 professional interest became more general, and the subject of lumbar puncture came up for discussion at various congresses and lectures.[9]

While Ziemssen pointed out the advantage of mixing the cerebrospinal fluid with medical agents in 1893, the first observer to replace the spinal fluid by a medicated one or a serum was Chipault[10] (1897), although cocaine had been introduced into the spinal canal (cauda equina) by Leonard Corning,[11] an American neurologist, ten years before Bier, the German physician, to whom the claim for priority for "medullary anæsthesia" is generally conceded.

Broadly speaking, lumbar puncture affords two ways of therapeutically influencing a given lesion:

1. By affording a road for the introduction of medicaments into the spinal canal, and from there to the cranial cavity, with the idea of producing a resultant action directly upon the cranial or spinal lesion.

2. As a means of producing favorable therapeutic action by withdrawal of excessive amounts of fluid, thus relieving pressure, and also simultaneously with the withdrawal of the fluid, bringing about the removal of causative foci of disease.

In the application of the first-named principle of lumbar therapeutics many drugs have been employed. Sterilized air (Weill), sodium salicylate (Caille), potassium iodide, iodoform, and antitetanus serum are some of many which have been found of use by various observers. The idea of a direct action on the meningeal lesion has not been generally successful from the practical standpoint; the greatest success has attended the introduction of the antitetanus serum, and at that this is by no means universally favorable. In tuberculous lesions the idea was particularly popular, but the therapeutic success doubtful.

The second therapeutic principle, the idea of producing a favorable therapeutic result from the withdrawal of spinal fluid, has brought forth wide divergence of opinion. We will study some of these opinions in detail.

The therapeutic value of lumbar puncture in meningitis has the endorsement and recommendation of many able observers; thus Quincke[12] finds it useful in cases of serous and seropurulent meningitis, a result which Goldscheider[12] and Oppenheimer[38] confirm from their own experience.

Its good effects in this condition are due to the relief of intercranial pressure (Osmond Goldan[13]). On the other hand, Stockton[14] and Browning[15] are not so positive in their claim for it in these forms of meningitis; they believe it of therapeutic value provided the first puncture gives good results, then they recommend its frequent repetition.

Kohts[16] reports lumbar puncture as having positive curative virtues in suppurative cerebrospinal meningitis, while Donath[17] only points out its sedative action in this condition.

In serous meningitis secondary to the exanthemata in children Wertheimer[19] reports most favorably on its therapeutic virtue. Friedrich,[139] in his recently published book, discusses the forms of operative interference in purulent meningitis inclusive of the method of repeated lumbar puncture, followed by injection of physiological salt solution for the evacuation of pus from the spinal canal. He, however, makes a counteropening into the cranial cavity to secure free evacuation of the purulent exudate.

The use of lumbar puncture in tuberculous meningitis has many adherents. It seems to have a sedative and analgesic effect, relieving the somnolence, and for a time even the coma (Kohts), while its action in relieving the intensity of the pain has also received favorable notice. Marfan[18] would limit its application to those cases of tuberculous meningitis where pressure symptoms develop along with incipient coma and hyperpyrexia, accompanied by loss of sensation, muscular flaccidity, and pupillary dilatation. Marian[20] unqualifiedly recommends its use in tuberculous meningitis.

An uncertainty of opinion exists among these various observers as to the relief which the measure affords to hyperdistention of the cerebrospinal fluid in this form of meningitis.

Francis Huber[21] is of the opinion that the therapeutic effect of lumbar puncture is a great one, and he uses it as a therapeutic measure in otitic serous meningitis, the cerebrospinal type of typhoid, and also in cerebrospinal meningitis.

In addition to the relief of pressure symptoms lumbar puncture serves to evacuate with the spinal fluid the larger part of the agents of suppuration, microbic and toxic, which have penetrated into the subarachnoidal space. It induces the secretion of a new cerebrospinal fluid which may be stronger in active bactericidal powers. (Brieger,[133] Pillagot,[134] and Hand[135]).

Originally designed by Quincke for the relief of hydrocephalic effusions, many observers have since confirmed his early results. Marian,[20] Bokey,[22] Pfandler,[23] Kohts,[16] and others have reported favorably in regard to its therapeutic value in cases of hydrocephalus, Marian, especially, holding the belief that its practice conduces to spontaneous recovery of the patient. According to these authors its results have been theoretically accounted for and practically demonstrated (Pfandler).

The procedure has been recommended to the general practitioner, especially to those interested in pediatrics. In hydrocephalus, complicated by spina bifida, Kohts obtained good results; Bokey reports its curative effect in hydrocephalus secondary to meningitis. In one case of chronic hydrocephalus all the symptoms disappeared after eight months, during which time eleven punctures had been made, withdrawing in all about 283 cm. of the fluid. A second case, although dying from an intercurrent disease, was much improved. Concetti[24] finds a palliative action the only one to be expected in chronic hydrocephalus.

Gradually the boundaries of the therapeutic indications for lumbar puncture were widened, and we find it recommended for the alleviation of the pains of chronic neuralgia secondary to zona by Abadie,[25] who obtained excellent results in three cases of neuralgia accompanying humoral zona and zoster. He found that the evacuation of 19 to 20 cm. of fluid served to relieve the pain. According to him the curative effect is to be sought for in the return of the pressure —spinal and intracranial—to the normal after hypertension because of the cerebrospinal fluid.

In headaches secondary to syphilis Campbell[26] found the puncture of excellent use. While Pfandler holds that the relief of symptomatic headache justifies its employment in this condition, the headaches of chlorosis are said to be almost immediately relieved by the abstraction of 30 to 60 cm. of spinal fluid (Wertheimer[19]). Lenhartz[28] reports eight such cases, seven improved.

On the other hand, Milian[27] brings contraevidence of its success in syphilitic headache. He used the puncture in a case of a young woman and withdrew only 6 to 7 cm. of fluid, yet the symptoms were aggravated to an excruciating degree, and there developed nausea with uncontrollable vomiting and accompanied by a thready pulse, leading to the classical picture of fatal syncope. This symptom-complex cleared up within a week.

The headaches of Bright's disease were treated and improved by means of lumbar puncture by Pierre Marie and Georges Guillian.[131] Furthermore, Schert states that the procedure brought instantaneous, though only temporary, relief with diminution of the œdema, and a clearing of consciousness in a case of uræmia. Sieffert[31] also reported favorably on the effect produced by the puncture on cases of uræmia following scarlatinal nephritis. He believes the procedure a valuable adjunct to other therapeutic measures in this condition. Legendre[137] is also among those who had successful therapeutic results in uræmia, while Legrain and Guyard[138] always obtained relief from headache and secured sleep by means of the puncture repeated at intervals of from a fortnight to a month in a patient aged fifty-six years suffering from chronic nephritis.

Among those inclined to place a therapeutic value on the puncture in cases of uræmia are Quincke, Furbringer, Lichtheim, and von Leyden.[120]

Finally, the headaches of chronic saturnine intoxication of the nervous system have been relieved and cured by means of the puncture at the hands of Seegelken.[153]

In affording relief to the lightning pains of tabes, especially during gastric crises with painful vomiting, Donath[29] was successful. Joseph Fraenkel used it successfully in seven such cases. He also found the puncture useful in diminishing the frequency and violence of epileptic attacks. Koranyi,[30] however, only expects palliative results in epilepsy; he does not expect a cure.

Good results from lumbar puncture have also been observed in Huntington's chorea, cerebral venous hyperæmia, and spastic torticollis (Donath).

Nor are these all the conditions where the puncture has been found of therapeutic value. In the treatment of meningeal œdema following traumatism it has proved useful (Lenhartz), and in cases of hemorrhage in the cord, the spinal punctures in the hnds of Strauss[32] again demonstrated its usefulneas. This author would restrict spinal puncture to those cases which occur in previously healthy persons where the hemorrhage resulted from traumatism.

Goldscheider[33] had favorable results from the puncture in two cases of small brain tumor situated at the base of the brain. Similar good results in this condition are reported by Kohts (two cases), while Masing[39] cautions against the employment of the puncture in cases of brain tumor, and relates the following case in point from his experience: The patient's condition was diagnosticated as a brain tumor, and the puncture was undertaken and 30 cm. of fluid withdrawn. During the operation there was nausea, later restlessness and vomiting, and finally death followed in fifteen hours after the operation. Autopsy showed extensive recent hemorrhage in the right temporal lobe, the wall being formed by a gliosarcoma (demonstrated per microscope) with central softening.

Of interest to otologists are the reports on the value of lumbar puncture in the management of dry otitis media, with its accompanying tinnitus; thus we find that Luminean[34] abstracted small amounts of spinal fluid, a procedure which he characterized as perfectly safe, to obtain relief in cases of cicatricial otitis—the dry form of otitis. He obtained relief from the annoying tinnitus and vertigo of labyrinthitis and its complications. His results were generally good. He even goes so far as to claim a "cure" for the tinnitus. Mignon,[35] on the other hand, claims to have observed an effect only in cases suffering from labyrinth troubles, secondary to an excess of pressure in the fluid of the internal ear. He obtained relief and cure of the vertigo and tinnitus in four cases under his observation. Occasionally he was able to observe a slight improvement in the hearing power, which he believes due more to the timely interference than to any other cause. On the other hand, Lombard and Caboche[36] have not had a single case of absolute cure among seven cases of dry otitis media with tympanic adhesions accompanied by deafness, tinnitus, and vertigo. The latter symptom was the one most favorably influenced by lumbar puncture. The last-named authors claim to have failed to establish any relationship between the improvement noted and the intraspinal pressure at the time of puncture. They noted the most favorable results in those cases where the patient presented marked vasomotor symptoms of the head and face.

Babinski[37] recommends rachicentesis as a therapeutic measure in the management of ear affections, more especially in auricular vertigo. He advocates the systematic adoption of lumbar puncture in the management of all chronic ear cases. Certainly, his remarkable curative results in treatment of ear affections—deafness, tinnitus, and auricular vertigo—merit the very serious attention of ear surgeons to this modern method, the effect of which he has demonstrated as infinitely superior to all and everything tried so far for the relief of dry, chronic, middle-ear disease. He treated eight cases with excellent results.) In several cases the psychic condition brought about by the ear disease improved at the same time. The power of hearing was very favorably influenced in a few instances, the good effects remaining fairly permanent, in one case over three months and a half at the time of the report.[130]

The rachicentesis recommended by Babinski in the management of ear affections, more especially of auricular vertigo, was tried by Tretrop with fortunate results in the treatment of deafness due to labyrinth trouble alone or complicated with other lesions of the hearing apparatus. The vertigo was the symptom most favorably influenced, next the tinnitus, and finally the deafness.

Tretrop[129] endorses the method for cases of deaf-mutism, especially when careful examination has demonstrated some remaining power for the perception of hearing in the internal ear. As to the dangers or contraindications of lumbar puncture in these conditions, Babinski says "presenting no dangers, and not exposing the patient who submits to it (the puncture) to an aggravation of his trouble, rachicentesis should be tried where there is no special contraindication in all patients suffering from auricular trouble rebellious to the various methods of local treatment." I cannot but think with Tretrop that this conclusion is too general, and suggestive of rather more than was meant by the author. Taking him literally, one would naturally proceed to puncture a goodly number of patients, the more so since he does not state after what length of time local treatment should be considered inefficient. In selected cases for the relief of vertigo and tinnitus there certainly appears to be evidence at hand that the procedure is of benefit, and occasionally the deafness has been improved to a considerable extent.

The manner in which these results are brought about must as yet be considered an open question. The changes produced in pressure in the internal ear fluids and the effect these may have on the disease have not yet been sufficiently established to warrant the formation of a theory. A favorable result in deafness should not invariably be expected, certainly not in cases where the labyrinth is destroyed.

Dangers of the Lumbar Puncture. Besides the opinion of many that the lumbar puncture has no very marked value, among whom Daskiwicz-Korybut,[40] Stadelman,[41] Ossipow,[42] and Braunstein can be counted, there are quite a few observers who believe the procedure a dangerous one. The cases recorded by Furbringer,[43] Broca,[44] Prouf,[45] Masing,[39] Mathers[50] and others are evidence of death caused directly by the puncture. Milian[46] holds the procedure responsible for the aggravation of the headaches and nausea. He observed signs of syncope, and interprets these as sequelæ due to disturbances in the balance of osmotic tension and pressure in the cerebrospinal fluid. Joseph Fraenkel[51] noted headache and nausea following the performance of lumbar puncture, but he was able to control the symptoms by saline injections.

Other observers, Heine,[47] Grossmann,[48] Lenhartz, Quincke Nissel, and Krǫenig,[49] while not holding the opinion that the operation is dangerous, still do not believe it an indifferent procedure. The consensus of opinion seems to be that the danger is lessened by avoidance of aspiration of the fluid, permitting it to come away in a spontaneous flow, and that the operation should be performed while the patient is in a lying posture.

In contradistinction to these views Chauffard and Boidin,[52] in a recent publication, dwell upon the great diagnostic value of the puncture, and consider it a safe means of interference capable of rendering most efficient assistance. Gordon,[53] Kohts,[16] and Conner[54] coincide with their opinion.

In summing up the question of the dangers from this procedure one must take a conservative position; that it has caused death is undeniable; a horizontal posture lessens the danger, and aspiration of the fluid is to be absolutely condemned. The procedure is contraindicated in cases of vascular sclerosis and aneurysms of the cerebral vessels in all acute and chronic affections of the central nervous system without pressure symptoms arising from the spinal fluid, the more so since the cerebral vessels are secondarily implicated in many of these diseases. The possibility of cerebral hemorrhage should always be kept in mind, especially when withdrawing large amounts of fluid. Small hemorrhages represent no danger to life; they may, however, exercise an unfavorable influence on the patient's future well-being (Ossipow).

III. As a Procedure to Produce Anæsthesia. The term "medullary anæsthesia," or "spinal anæsthesia," was first used by Bier[140] and Braun[141] for the insensibility resulting from an injection of a cocaine solution into the spinal canal; the ultimate cause of this anæsthesia being an interruption of the nervous continuity in the lumbar space, and also of the spinal nerve roots.

Twenty years ago Corning,[11] the originator of the idea of influencing the spinal marrow (the nerves of the cauda equina) by means of directly applied medicaments, discussed irrigation of the cauda equina with medicinal fluids, referring also to the effects of cocaine on the cauda and its eventual surgical bearing.

The subject in general, and his work in particular, attracted little attention until Bier published his article in 1899 on "Medullary Anæsthesia." Quincke[2] perfected the technique of lumbar puncture, and Sicard demonstrated the analgesia resulting as an effect of cocaine injections into the spinal canal of dogs.[142] Chipault,[143] Jaboulay,[144] Jacob,[145] and others insisted upon the harmlessness of subdural injections of medicinal agents.

Led by Tuffier,[146] French surgeons were universally and a little prematurely enthusiastic on the subject of medullary anæsthesia.

The not infrequent direct and remote untoward results caused authorities like Mikulicz[147] and others to abandon medullary anæsthesia after having given it a fair trial.

Guinard[148] first recommended the cerebrospinal fluid itself as a solvent for the anæsthetic (cocaine) in order to prevent the meningeal irritation resulting from the physical or chemical effects of the watery solution which had up to this time been used. The same idea had occurred to Kozlowski,[149] and both these observers soon reported favorably on the results of their improved technique and medication. The otherwise frequent untoward sequelæ of lumbar anæsthesia were absent in all the latter's cases.

It is a noteworthy fact, according to Braun, that old, anæmic, and weak patients remained remarkably free from untoward accidents, standing grave and protracted operations without any impairment of their general condition. According to Morris, lumbar suprarenin-cocaine injections have never been observed to cause rise in the blood pressure. In some cases the blood pressure remains unchanged, in the majority of instances it falls more or less, most markedly in those cases in which the well-known side effects present themselves and go on to slight collapse, with abundant perspiration, nausea, and vomiting. Morris made this observation in nine out of fifty cases.

Without going into detail it suffices to say of medullary anæsthesia that the enthusiastic endorsement accorded it at its introduction into this country some few years ago is on the wane. It is still a valuable procedure in selected cases, but many operators, both here and abroad, have abandoned and condemned it. Deaths occurred directly attributable to the lumbar anæsthesia and to the intoxication from the drugs used.

To modify the phenomena of intoxication, Bier recommended a combination of cocainization with an artificially induced congestive cerebral hyperæmia. The idea is based on the well-known fact that the cerebrospinal fluid is rapidly drawn into the spinal canal when space is encroached upon. A congestive venous hyperæmia will artificially produce such an encroachment. Before the injection of cocaine (or B. eucaine) a bandage is placed so tightly around the neck that it becomes cyanotic, and leaving the bandage in place for some time after operation so as to circumvent the danger of a sudden back flow of the cocaine into the brain, together with the cerebrospinal fluid.

The technique of the spinal puncture is so well described in the recently published work of Braun[150] that it has not been deemed advisable to reproduce the description of the method of procedure, the operation being now rather infrequently performed in this country.

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NON-PARASITIC CYSTS (CONGENITAL) OF THE LIVER, WITH A STUDY OF ABERRANT BILE DUCTS.

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INTRODUCTION.

1. *Frequency, Size, and General Features.*

Non-parasitic cysts of the liver belong to the rarer lesions of this organ. Only 85 cases, as far as I can ascertain, have been recorded. These cysts are, as a rule, multiple, and are most abundant in the zone of the liver just beneath the capsule. They vary from those which are microscopic to those which occupy nearly the entire liver. The contents of the cysts are a clear, watery, or yellowish-brown fluid, containing small amounts of albumin, mucin, cholesterin, a few epithelial cells, leukocytes, red blood cells, and a finely granular debris. Hematoïdin crystals are rare findings in old cysts. In no instance has bile or biliary pigment been found. The cavity may be single or trabeculated. The gall-bladder and ducts, are in the very large majority of cases, free.

Such cysts occur in both sexes about equally in my statistics, although Forbes says that females are more frequently affected in the ratio of three to one. They occur at all ages, and have been found twice in the fetus, seven times in the newly born, four times in